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КОНФЕРЕНЦИЯ ОРГАНИЗАЦИИ ОБЪЕДИНЕННЫХ НАЦИЙ
ПО ВОПРОСУ О ПРИМЕНЕНИИ НАУЧНЫХ И ТЕХНИЧЕСКИХ ЗНАНИЙ
ДЛЯ УДОВЛЕТВОРЕНИЯ ПОТРЕБНОСТЕЙ МЕНЕЕ РАЗВИТЫХ РАЙОНОВ

ПУНКТ ПОВЕСТКИ ДНЯ: D.1.1

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КОНЦЕНТРАЦИЯ ПРОИЗВОДСТВА И РАЗМЕРЫ ПРЕДПРИЯТИЙ В ПРОМЫШЛЕННОСТИ

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Документы, составленные для Конференции Организации Объединенных Наций по вопросу о применении научных и технических знаний для удовлетворения потребностей менее развитых районов, служат в качестве рабочих документов для этой Конференции. Они опубликованы в том виде, в каком были представлены их составителями, и их содержимое и выраженные в них мнения принадлежат их составителям (см. примечания на оборотной стороне).

ПРИМЕЧАНИЯ

1. Документы, включенные в число материалов, принятых для обсуждения на общих сессиях, будут в распоряжении делегатов Конференции на следующих официальных языках Организации Объединенных Наций: русском, английском, испанском и французском.

2. Документы, включенные в число материалов, принятых для обсуждения на специализированных сессиях, будут в распоряжении делегатов Конференции только на одном из этих официальных языков.

3. Резюме всех документов в том виде, в каком они были представлены их составителями, будут в распоряжении делегатов Конференции на следующих официальных языках Организации Объединенных Наций: русском, английском, испанском и французском.

4. До открытия Конференции документы и резюме не будут выпущены для общего распространения. Они будут опубликованы заблаговременно только в ограниченном числе экземпляров и исключительно для правительственных делегаций и других правомочных участников. Последующие опубликование и рассылка трудов Конференции будут обеспечены в соответствии с практикой Организации Объединенных Наций, как это установлено ее Издательским комитетом.

КОНЦЕНТРАЦИЯ ПРОИЗВОДСТВА И РАЗМЕРЫ ПРЕДПРИЯТИЙ В ПРОМЫШЛЕННОСТИ

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Концентрация производства, как процесс сосредоточения производства продукции на все более крупных предприятиях – один из важнейших законов развития материального производства в промышленности – является необходимой предпосылкой применения высокопроизводительной новейшей техники, осуществления рациональных форм специализации, кооперирования и комбинирования предприятий, внедрения прогрессивных типов организации производства на предприятиях массового производства, непрерывного потока. Следовательно, концентрация производства обеспечивает высокую экономичность деятельности производства: благодаря высокой концентрации производства достигается наибольшие результаты при наименьших затратах овеществленного и живого труда.

Повышение уровня концентрации производства – закономерное явление развития капиталистической промышленности. Систематически возрастает доля крупных предприятий во всех отраслях производства во всех капиталистических странах. Империалистическая стадия капитализма характеризуется пооедой крупных и крупнейших предприятий, по сравнению с которыми миллионы средних и мелких предприятий играют все более подчиненную роль.

Но капиталистическая концентрация развивается в тесной связи с законом анархии производства и конкуренции. В конкурентной борьбе побеждает крупный, монополистический капитал, который сосредоточивает производства на крупнейшие предприятия, использует экономические преимущества крупных предприятий для экономического уничтожения более мелких предприятий.

Вместе с тем, продолжают существовать десятки тысяч мелких предприятий, которые не в состоянии применить новейшую технику и рациональные формы организации производства. Достаточно указать, что в обрабатывающей промышленности США предприятия с числом занятых от I до I9 человек составляют свыше I90 тысяч /69% всех предприятий/. Однако доля этих предприятий в общем выпуске продукции едва достигает 6%. Эти мелкие предприятия живут недолговечно, систематически разоряются, не в состоянии выдержать концентрации крупных монополии.

Концентрация производства и господство монополий приводит ко все большему обобществлению капиталистического производства. Но результаты этого обобществления не идут в пользу всего общества; богатеет небольшая кучка магнатов. Углубляется основное противоречие капитализма – противоречие между общественным характером производства и частнокапиталистической формой присвоения.

Концентрация производства в социалистической промышленности принципиально отличается от концентрации при капитализме. Социалистический способ производства, его экономические законы открывает неограниченные возможности развития концентрации производства в связи с чем в социалистической промышленности достигается наиболее высокая степень обобществления труда. Социалистическая промышленность – самая концентрированная промышленность в мире. В связи с этим она может развиваться на основе самой передовой техники и обеспечивать высокие темпы роста производительности общественного труда.

Концентрация производства в социалистической промышленности осуществляется планомерно. В каждой отрасли промышленности устанавливается целесообразное сочетание крупных и небольших предприятий, в

зависимости от уровня техники, характера размещения предприятии по территории страны. но общая тенденция заключается во все большем увеличении доли крупных предприятий, во все большем увеличении их значения в народном хозяйстве.

промышленность СССР достигла высокой степени концентрации производства.

Так, в черной металлургии заводы с выплавкой чугуна свыше I млн. тонн в год выплавляли в 1960 году 85,5% годовой выплавки чугуна. Электростанции, мощностью 100 тыс. квт. и выше в 1959 году производили 69% всей электроэнергии. В хлопчатобумажной промышленности по данным на I января 1956 года около 45% всех прядильных веретен и текстильных станков было сосредоточено в крупнейших предприятиях, имеющих 100 тыс. веретен и 2000 ткацких станков.

Размеры предприятий характеризуют уровень и степень концентрации производства в промышленности, поскольку концентрация производства - это процесс сосредоточения производства в крупных предприятиях. От размера предприятий зависит возможность использования новейшей, наиболее производительной техники, а, следовательно, достижения высокой производительности труда. Размер предприятия является существенной предпосылкой осуществления таких прогрессивных форм организации производства как специализация, кооперирование и комбинирование, массовое производство и непрерывный поток. Размер предприятия оказывает влияние на рациональность размещения промышленности по территории страны и внутри экономических районов. От размера предприятия зависит весь комплекс технико-экономических показателей как при строительстве предприятия /удельные капитальные затраты/, так и при его эксплуатации /себестоимость продукции/.

Но всегда ли высокий уровень концентрации производства характеризует и высокую экономическую эффективность производства? Очевидно, что такая зависимость будет иметь место лишь в тех случаях, когда функционирующие предприятия являются оптимальными. Если же эти предприятия характеризуются только большими размерами, то уровень концентрации не может явиться показателем экономической эффективности производства.

В связи с этим весьма существенным становится вопрос об измерителях уровня концентрации производства в промышленности. В частности какой показатель наиболее полно характеризует этот уровень, а следовательно и размер промышленного предприятия?

Известно, что для определения уровня концентрации промышленного производства применяется ряд показателей - стоимость продукции, численность рабочих /или работающих/, размер основных фондов, энерговооруженность. По одному из этих показателей, чаще всего по численности рабочих или по стоимости продукции, производится группировка предприятий и устанавливается доля отдельных групп предприятий в отрасли или в целом по промышленности по одному или совокупности вышеуказанных показателей. Тем самым устанавливается роль отдельных типов предприятий в экономике отрасли или в промышленности в целом. Динамика удельных весов каждой группы предприятий по важнейшим показателям производства и характеризует процесс концентрации производства.

Следует отметить, что в связи с техническим прогрессом такой показатель, как численность рабочих, становится не характерным для процесса концентрации; величина основных фондов лишь косвенно характеризует концентрацию производства. Показателем, который отражает действительный уровень концентрации и размер предприятия, может быть только количество или стоимость произведенной продукции.

Рост размеров предприятий и усиление процесса концентрации производства в промышленности вытекает из экономических преимуществ крупного производства и из закономерных тенденций технического прогресса и улучшения технических параметров средств производства и особенно орудий труда. Одной из существенных особенностей развития современной техники является укрупнение агрегатов, машин и механиз-

нов, увеличение их мощности и производительности. Эту особенность можно показать на примере ряда отраслей промышленности СССР.

В черной металлургии происходит систематический рост мощности основных агрегатов. Для доменного производства характерным является увеличение полезного объёма доменных печей. В настоящее время вводятся в действие доменные печи с полезным объёмом в 1513, 1736 и 2000 мт^3. Аналогичное явление наблюдается и в сталеплавильном производстве. Вместо мартеновских печей емкостью в 70-100 тонн, типичными становятся печи емкостью в 250, 300 и даже 500 тонн. Намечается ввод в действие электропечей емкостью до 180 тонн, вместо печей емкостью 40 тонн. В прокатном производстве создаются блюминги годовой мощности 3-4 млн. тонн, прокатные станы производительностью до 3 млн. тонн. В производстве кокса создаются восьмибатарейные заводы с годовой производительностью в 3,8 млн. тонн валового кокса, вместо четырехбатарейных заводов, производительностью 1,8 млн. тонн в год.

В большинстве отраслей машиностроения ярко проявляется тенденция к укреплению производимых машин и агрегатов. Так в энергетическом машиностроении систематически увеличивается мощность котлов, турбин и генераторов. Осваиваются производство паровых турбин мощностью 200, 300 и 500 тыс. квт., гидрогенераторов 200 и 250 тыс. квт., паровых котлов с давлением пара 130 атмосфер при температуре до 565^{0}С. Осваивается турбинный блок мощностью 300 тыс.квт. с давлением пара до 300 атм. при температуре 650^{0}С.

В строительно-дорожном машиностроении производятся мощные машины, экскаваторы, бульдозеры, подъемно-транспортные агрегаты. Шагающий экскаватор, например характеризуется емкостью ковша в 25 м^3 и с длинной стрелы 100 метров. Производятся большегрузные скреперы с ковшами в 10 и 15 м^3, самоходные краны грузоподъёмностью до 50 тонн, землесосные снаряды мощностью 1000 м^3 грунта в час, автосамосвалы грузоподъемностью до 40 и более тонн, бетономешалки емкостью 2400 л.

В станкостроительной промышленности систематически увеличивается производство высокопроизводительных агрегатных станков, автоматических станочных линий, рассчитанных на производство больного количества деталей машин.

Осваивается производство мощных агрегатов для бумажной и резиновой промышленности, полиграфических машин, машин для производства искусственных волокон. В текстильном машиностроении осваивается производство мощных машин, сокращающих число переходов при изготовлении пряжи, отделочных агрегатов.

Увеличение мощности и производительности производственного оборудования и машин является наиболее существенным фактором роста размеров предприятий и усиления процесса концентрации в отдельных отраслях промышленности.

Такая тенденция технического прогресса вытекает из требований экономики промышленного производства и отвечает задаче всемерной экономии общественного труда.

Следует подчеркнуть, что чем больше мощность и производительность машин и агрегатов, тем лучше показатели экономической эффективности как процесса их производства, так и процесса их эксплуатации по отдельным видам оборудования.

Рост полезного объема доменных печей сопровождается сокращением удельных капиталовложений и удельной потребности в оборудовании на один куб.метр объёма печи, что видно из следующих данных:

Полезный объём доменной печи	Кап.затраты на 1м^3 полезного объёма печи /в тыс.р./.	Потребность в оборудовании на 1 м^3 пол. объёма печи /в тоннах/
1053	29	2,2
1386	27	-
1513	26	1,6
1719	23	1,5
2286	22	1,5

Строительство 8-9 мартеновских печей емкостью 370 тонн каждая требует капитальных затрат на 10% меньше, чем строительство 12-13 печей емкостью по 185 тонн каждая. При этом в первом случае производительность труда выше в 1,6-2 раза; удельный расход топлива 173 кг, вместо 215 кг. себестоимость стали на 23% ниже.

В нефтеперерабатывающей промышленности рост производительности атмосферно-вакуумных установок так же характеризуется улучшением важнейших экономических показателей.

Производительно атмосферно-вакуумной установки /в тыс. тонн в год/	Удельные капитальные вложения	Эксплоатационные расходы
600	19,1	13,1
1000	17,8	12,6
2000	12,6	8,8

В энергомашиностроении для изготовления одного турбогенератора в 100 тыс. квт. требуется на 25-30% меньше станкочасов, чем для изготовления 4 турбогенераторов по 25 тыс. квт.

Концентрация производства в промышленности является предпосылкой экономии общественного труда потому, что крупные предприятия обладают значительными экономическими преимуществами. Эти преимущества вытекают из того, что труд на крупном предприятии функционирует в наиболее общественном виде.

Следующие экономические преимущества характеризуют крупное производство:

1. Производительность оборудования, мощность предприятия растет быстрее стоимости оборудования и стоимости основных фондов в целом. В связи с этим стоимость единицы установленной мощности /удельные капиталовложения/ понижается по мере увеличения мощности предприятия.

2. На крупном предприятии достигается более высокое использование установленного оборудования и производственных площадей, благодаря большой экстенсивной и особенно интенсивной нагрузке.

3. В крупном производстве создаются предпосылки для более целесообразного разделения труда внутри предприятия, в частности для специализации отдельных участков производства. Это способствует внедрению более производительного оборудования, прогрессивной технологии и организации производства, эффективному использованию средств комплексной механизации и автоматизации.

4. Крупное производство позволяет экономнее использовать предметы труда, особенно, сырье, материалы и топливо. Это обеспечивается, с одной стороны, сокращением удельных норм их расхода в связи с применением более совершенных технологических методов, с другой, - созданием в условиях крупного производства возможностей для более полного использования отходов и побочных продуктов вплоть до комплексного использования сырья.

5. На крупном предприятии так называемые накладные расходы относительно меньше, чем на небольших предприятиях, ибо эти расходы, в частности расходы по управлению и обслуживанию производства, увеличиваются непропорционально росту масштабов производства. Крупное производство позволяет оснастить предприятие прогрессивными средствами оргтехники, механизировать учет вплоть до применения электронных вычислительных машин, что резко сокращает расходы по управлению производством.

6. В условиях крупного предприятия становится экономически целесообразным создание конструкторских бюро, лабораторий, опытных установок. Такого рода учреждения обеспечивают технический прогресс и совершенствование организации производства, научный контроль производства. На этой основе достигается улучшение технико-экономических показателей деятельности производства. Затраты на создание этих учреждений и их функционирование, при крупных масштабах производства относительно не велики и окупаются в весьма короткие отрезки времени.

Высокий уровень концентрации производства является важнейшим фактором повышения экономической эффективности капиталовложений. При строительстве крупных предприятий меняется структура капитальных затрат - снижается удельный вес стоимости строительно-монтажных работ и увеличивается удельный вес затрат на оборудование, т.е. на активную часть основных фондов. Изменение структуры капитальных затрат зависит в значительной степени от уровня индустриализации строительства, который прежде всего определяется размерами строящихся промышленных объектов.

Наибольший прирост продукции на каждый затраченный рубль капитальных вложений, т.е. удельные капитальные затраты находятся в непосредственной зависимости от размера предприятий. Эта зависимость - чем больше размер предприятия, тем ниже удельные капитальные затраты - проявляется во всех без исключения отраслях промышленного производства. Покажем эту зависимость на примерах из различных отраслей промышленности.

Повышение мощности металлургического завода в полтора раза, сопровождается снижением удельных капитальных затрат на тонну проката до 20 процентов. В целлюлозной промышленности увеличение мощности заводов до 2,5 миллионов тонн в год уменьшает удельные капитальные затраты на 25% по сравнению с существующим уровнем. Повышение мощности тепловых электростанций до 1200 тыс. квт. снижает удельные капитальные затраты на 25-30% по сравнению со станциями мощностью в 300 тыс. квт. В текстильной /хлопчатобумажной/ промышленности, на ткацких фабриках с количеством станков 1332 удельные капитальные затраты на 10 процентов ниже по сравнению с фабриками с количеством станков - 673. В сахарной промышленности переход к строительству заводов, перерабатывающих в сутки 30-50 тыс. центнеров свеклы уменьшает удельные капитальные затраты на 25% по сравнению с заводами мощностью 15 тыс. центнеров в сутки.

Себестоимость продукции, производительность труда и ряд других качественных показателей деятельности производства также характеризуют эффективность капитальных вложений. И эти показатели находятся в зависимости от размеров предприятий, что подтверждается многочисленными данными различных отраслей промышленности.

Необходимо подчеркнуть условность понятия крупного или среднего предприятия. Говоря о размере предприятия, надо иметь в виду его зависимость от уровня развития техники и характера специализации производства. При высоком уровне техники, развития электрификации и автоматизации производства, углублении подетальной и технологической специализации так называемые средние /и даже мелкие/ предприятия имеют все экономические преимущества крупного производства. Такие предприятия по масштабам годового производства продукции /а только этот показатель отражает действительный уровень концентрации/ следует относить к крупным предприятиям, а повышение же удельного веса в общем объёме данной отрасли промышленности характеризует усиление процесса концентрации производства.

Экономические преимущества крупных предприятий отмеченные выше проявляются лишь при определенных предпосылках. Такими предпосылками служат повышение технического уровня производства с ростом его объёма, совершенствование технологических методов, специализация производства. Без этих предпосылок укрупнение производства во многих случаях не оказывает существенного влияния на снижение затрат, особенно эксплуатационных издержек. При неизменности техники и технологии, многообразии номенклатуры изготовляемых изделий укрупнение производства может сопровождаться даже ухудшением экономических показателей в связи с недоиспользованием производственных мощностей, возрастанием накладных расходов, нерациональным использованием сырья и материалов.

Известно, что решающим условием снижения затрат на производство промышленной продукции является рост производительности труда. Источником ее повышения служит совершенствование техники и организации производства, улучшение конструкций орудий труда и методов технологии. Если укрупнение производства не сопровождается изменениями в технике и организации производства /особенно развитием специализации/, то не может быть достигнут существенный рост производительности труда, а следовательно, не снизятся и затраты на производство продукции. Этим главным образом и объясняются наблюдающиеся в практике случаи, когда крупные предприятия характеризуются худшими качественными показателями, чем предприятия меньших размеров.

Следовательно высокий уровень концентрации производства не всегда характеризует высокую экономическую эффективность производства. Очевидно, что такая зависимость будет иметь место лишь в тех случаях, когда функционирующие предприятия отличаются не только большими размерами, но и являются для данной отрасли промышленности оптимальными. Критерием оптимальности предприятия надо считать возможность максимальной загрузки наиболее прогрессивного в данной отрасли основного оборудования и применения наиболее совершенных технологических процессов и передовой организации производства. Оптимальным размерам предприятия следует считать такой размер, при котором достигаются лучшие технико-экономические показатели производства, в частности наименьшие удельные капитальные затраты и наименьшая себестоимость /эксплуатационные издержки/ продукции на предприятии. Разумеется, что лучшие технико-экономические показатели могут быть достигнуты только при условии применения наиболее прогрессивной техники и при возможности максимального ее использования.

Таким образом, факторами оптимальности размера предприятия являются техника и организация производства, возможность максимальной загрузки системы машин на предприятии. Вместе с тем целесообразные размеры предприятий зависят еще от их местоположения, от районных особенностей - характер и масштабы потребления продукции, сырьевые ресурсы, объём транспортной работы. Районные условия оказывают весьма значительное влияние на уровень технико-экономических показателей деятельности предприятий. Но каковы бы ни были районные условия размер предприятия должен быть таким, при котором может быть использована наиболее прогрессивная техника. В противном случае будут создаваться не эффективные предприятия.

Прежде чем решать вопрос о том, где и в каком количестве размещать предприятия нужно установить, что размещать, т.е. установить оптимальный размер предприятия в данной отрасли производства в соответствии с указанным выше критерием оптимальности. При разработке этого вопроса следует иметь ввиду экономическое своеобразие различных отраслей промышленности. Специфика отраслей влияет на установление размеров предприятий. С точки зрения подхода к определению размера предприятий, отрасли промышленности следует разбить на три группы.

Первая группа - отрасли, в которых увеличение размера предприятия непосредственно зависит от роста мощности и производительности ведущего оборудования и системы машин. К такого рода отраслям относятся: черная металлургия, электростанция, многие отрасли химической промышленности. В этих отраслях размеры отдельных предприятий отличаются не столько количеством однотипного оборудования, сколько мощностью и производительностью агрегатов. Крупная электростанция или металлургический завод отличаются от средних предприятий прежде всего мощностью котлов, турбоагрегатов, объемом доменных печей и мартенов. В связи с этим на более крупных предприятиях в этих отраслях используется и более совершенная технология производства, обеспечивающая наибольшую загрузку оборудования. Все это в конечном итоге приводит к тому, что чем крупнее предприятие, тем лучше

все технико-экономические показатели как при строительстве, так и при эксплуатации предприятий.

Отрасли этой группы относятся к капиталоемким производствам с большим удельным весом активной части в структуре основных фондов. Для характеристики степени экономической эффективности этих производств существенным показателем является удельные капиталовложения, а себестоимость продукции в огромной мере зависит от степени использования производственной мощности предприятий. Кроме того, чем мощнее агрегаты, тем ниже нормы расхода сырья и материалов, что также влияет на снижение себестоимости.

Вторая группа - отрасли, в которых увеличение размера предприятия не вызывается увеличением мощности и производительности оборудования. В этих отраслях промышленности размеры отдельных предприятий отличаются лишь количеством однотипного оборудования. К этой группе отраслей относятся: текстильная, кожевенно-обувная, швейная, некоторые отрасли машиностроения. Крупная текстильная фабрика отличается от средней количеством ткацких станков, прядильных веретен. Технологический процесс изготовления продукции одинаков на предприятиях различного размера. В связи с этим нормы производительности оборудования, нормы расхода предметов труда не находятся в зависимости от размера предприятия.

Эти отрасли промышленности относятся к материалоемким производствам. Удельный вес зарплаты в себестоимости продукции этих отраслей относительно невелик. Общие расходы занимают незначительную величину в издержках производства. В связи с этим укрупнение предприятий в этих отраслях не отражается существенно на сокращении эксплуатационных издержек. Снижение же удельных капиталовложений при увеличении размера предприятий в связи с относительно малой капиталоемкостью этих производств не может являться основным показателем для экономической эффективности. Снижение себестоимости продукции в такого рода производствах достигается прежде всего за счет экономии сырья и материалов, а эта экономия не зависит от размера предприятия.

Третья группа - эта отрасли добывающей промышленности, в которых размер предприятия зависит прежде всего от горно-технических и геологических условий его местоположения. Но поскольку эти отрасли капиталоемки, то для них показатель удельных капиталовложений и использования основных фондов наиболее существенны при определении эффективности капиталовложений. В таких отраслях как угольная, рудная, весьма высока доля заработной платы в себестоимости продукции. Снижение себестоимости продукции в этих отраслях достигается прежде всего за счет сокращения доли расходов на зарплату, что может иметь место лишь при условии роста производительности труда, уровень который непосредственно зависит от размера предприятий в отраслях добывающей промышленности.

Промышленность, создаваемая в слабо развитых странах, должна характеризоваться высокой степенью концентрации. Строительство предприятий ниже оптимального размера, в которых не может быть использована прогрессивная техника и организация производства экономически не целесообразно. Оптимальные размеры предприятий и высокий уровень концентрации производства - наиболее целесообразный путь развития промышленности в слаборазвитых странах, обеспечивающий рост производительности общественного труда, увеличение масштабов производства, с наименьшими затратами овеществленного и живого труда. Об этом свидетельствует богатый опыт развития промышленности Советского Союза.

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USSR

CONCENTRATION OF PRODUCTION AND THE SIZE OF INDUSTRIAL ENTERPRISES

By L.I. ITIN, D.Sc.(Econ.)

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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CONCENTRATION OF PRODUCTION AND THE SIZE OF INDUSTRIAL ENTERPRISES

Concentration of production, being the process of amalgamating the output of commodities at enterprises of an ever increasing size, is a major law of developing material production.

The level of production concentration in industry should be measured by the share of large enterprises in the output value or in the quality of products in a given industry. The proper size of an enterprise can be determined only by its annual output. The number of the personnel, the cost of plant and equipment define but indirectly the size of enterprises and cannot be used for fixing their optimal size .

An increase in the size of enterprises and intensification of the process of production concentration in industry follows from the economic advantages of large-scale production and from the law-governed tendencies to technical progress. Enlargement of units and equipment , and an increase in their capacity and productivity is inherent in the development of techniques of industrial production. Such a tendency to technical progress is brought about by the requirements of the economics of production and the task of all_round saving of social labour as the major criterion of development of social production. The greater the capacity and productivity of equipment the better the records of their economic effectiveness of their production and operation.

The economic advantages of large enterprises are manifested under certain conditions only. These are: higher technical level of production in proportion to its increased volume,and specialization of production. With techniques and the diversity of the articles produced unchanged, enlargement of enterprises may even entail a worsening of economic criteria.

The advantages of large enterprises can be derived only in such cases when such enterprises are optimal in the given industry. The maximum possible use of equipment, the most up-to-date in the given industry, and application of modern technology and organization of production should be regarded as the criterion of optimal enterprises. Such a size of an enterprise should also be considered optimal, in which the best possible technical and economic indications of the work of the enterprise are achieved.

At the same time the advisable size of enterprises also depends on the specific features of their location. But whatever the local conditions, the size of an enterprise should be such as to make the utmost use of the latest techniques and organization of production.

When fixing the optimal size of enterprises, account should be taken of the economic peculiarities of various

industries, notably: the kind of equipment and technology of production, the structure of operational costs and the amount of capital required in the industry.

If so viewed, all industries should be divided into three groups:

The first group comprises industries in which an increase in the size of enterprises depends on the expansion in the capacity of equipment. Such industries include the iron and steel industry, electric power stations and the chemical industry. The sizes of individual enterprises in these industries differ not so much by the amount of equipment of the same type as by the capacity of the units. The larger the enterprise, the better all the technical and economic records.

The industries of this group require considerable amounts of capital. Specific capital investments define the degree of economic effectiveness of such enterprises, while the cost of products overwhelmingly depends on the extent to which the capacity of the enterpises is used.

The second group embraces industries in which an increase in the size of an enterprise is not caused by a greater capacity or productivity of equipment. The sizes of individual enterprises in these industries differ but by the amount of equipment of the same type. This group of industries includes: the textile, the leather and shoe, and clothing industries, and some branches of the engineering industry. The technological process is the same at enterprises of different sizes. As a result, the standards of equipment output and of labour product consumption do not depend on the size of the enterprise.

Such industries consume great quantities of supplies. The share of wages in the cost of products is relatively small in these industries. Overhead charges form a small proportion of the total production costs. In view of this, enlargement of enterprises in such industries does not affect substantially any reduction in operating costs. Reduced cost of products in such industries is primarily achieved by economizing raw materials and other supplies, and such savings do not depend on the size of an enterprise.

The third group comprises extracting industries in which the size of the enterprise depends above all on the mining, technical and geological conditions of its location. But as such industries require a lot of capital, the criterion of specific capital investments and of the use of plant and equipment is most important in these cases in determining the effectiveness of capital investments. In such industries as coal mining and ore mining, the proportion of wages in the costs of output is rather high. A reduction in the costs of output in such industries is primarily obtained by a lower amount of wages, which can be achieved only when labour productivity rises. And the level of the latter is directly dependent on the size of enterprises in extracting industries.

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Agenda Item: D.6.1

Australia

METHODS OF INCREASING THE USEFULNESS OF NATURAL WOOL

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METHODS OF INCREASING THE USEFULNESS OF NATURAL WOOL

F.G. Lennox[1]

INTRODUCTION

1. This paper is based on the work and experiences of the Wool Research Laboratories of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.). These Laboratories were established in Australia in 1949 and comprise the Division of Protein Chemistry in Melbourne, the Division of Textile Physics in Sydney and the Division of Textile Industry in Geelong.

2. The main objective of the Laboratories is to ensure maximum efficiency in the utilization of wool; that is, in the handling of wool after shearing the sheep, in all stages of transport, marketing, cleaning the wool in the mill, textile processing and in satisfactory performance of wool goods in the hands of the consumer. Research to improve wool production, covering breeding, nutrition and diseases of sheep will not be mentioned in this paper.

3. To achieve the above objective, the major proportion of the research is directed to the immediate application of existing scientific and technical knowledge to the improvements of the practical processes and operations of the wool industry. Considerable attention is also given to research on the structure of wool and its physical and chemical properties in order to reveal new information and provide a basis for practical improvements in the industry of an unexpected nature. Improvements made in the wool industry, derived from both these approaches, will be dealt with in this paper.

4. The bulk of Australian wool comprises fine Merino wool of 60's to 64 s quality. Over 90% of the wool is exported and most of it is used in the manufacture of worsted yarn, for example, for mens' suits and machine knitwear. Much of the research programme is therefore concerned with processes of the worsted industry. Since no Australian wool is used in woven carpets the research programme does not include studies on carpet yarns. On the other hand, much of the research carried out in the Wool Research Laboratories has relevance to all types of wool, whatever their properties, and also to other animal fibres, such as mohair and vicuna, because of their essential similarity to wool in histological and chemical structure.

STRUCTURE AND PROPERTIES OF WOOL

5. As grown on the sheep, wool fibres are covered with a protective

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layer of yolk, consisting of ether soluble wax or wool grease from the sebaceous glands, and water soluble suint from the sweat glands located in the skin of the animal. The fleece is also contaminated with dust collected from the atmosphere and with some vegetable matter from the pasture. When cleaned by scouring and examined with the optical microscope, Merino wool is seen to contain masses of spindle-shaped cortical cells with their lengths oriented in the same direction as the fibre length and together comprising the main core of the fibre or cortex. The cortex is covered with overlapping scale cells resembling the tiles on a roof. In Merino wool there are two kinds of cortical cell, those lying in the outer half of the fibre at each crimp bend and having a strong affinity for certain dyes, known as the ortho cortical cells, and those lying on the inside of the bend and having less affinity for the dyes, known as the para cortical cells. Inside the cortical cells are fibrous structures known as macrofibrils. Examination of wool with the electron microscope reveals inside each macrofibril masses of microfibrils 70Å in diameter and also running in the direction of the wool fibre. They are separated from each other by a sulphur-rich matrix. Each microfibril in turn contains about eleven protofibrils, each approximately 20Å in diameter. The microfibrils probably correspond to the low-sulphur proteins. Both groups of proteins can be extracted from wool with alkaline thioglycollate solution and with other chemical reagents.

6. Besides studying the chemical reactivity of chemical groups in wool, which are responsible for example for its remarkable setting and dyeing properties, wool fibres are being characterized in terms of their strength and elasticity as building units in textile construction. Their frictional properties are being studied, since these determine the ability of the fibres to felt, and are most important in mechanical operations such as carding, combing and spinning. Also the affinity of wool for water is under continuous investigation. The gain and loss of water is of immense importance in the marketing of wool since the amount of water absorbed from the atmosphere will greatly affect the weight of a given lot of wool. It also affects the performance of wool in processing and during use by the consumer and is of major importance in wet processing and drying.

TRANSPORT AND MARKETING OF WOOL

7. When wool is shorn it is packed in jute bales. Overseas buyers have complained that Australian wool is sometimes contaminated with jute fibres, which have a dye affinity differing from that of wool, causing them to appear as blemishes in fine wool fabrics. Investigations have shown that the fibres partly arise from jute strings used to tie groups of jute packs together and frequently enclosed in the pack with the wool. Growers have been circularized asking them to remove all such strings from their packs before baling the wool.

8. Another source of jute fibre contamination is the loose fibre on the surface of the jute fabric which adheres to the wool when it is being packed. While exploring the possibility of preventing such contamination by using a thin polythene liner inside the jute pack, a method was discovered of reducing the wool to a low volume by evacuating the air from a polythene bag containing wool with the aid of a milking machine type vacuum pump. Greater densities of wool are attained by this method than with the conventional hand press, thereby reducing transport costs from shearing shed to store. Moreover less labour is needed than in the conventional method and loss and gain of moisture in the wool are greatly reduced. The method has been paten-

ted and is being examined to assess its commercial possibilities.

9. Estimation of the maximum price per lb that the wool buyer should bid at auction is based on long experience in the wool industry and knowledge of the processing to which the wool will be subjected. The buyer will attempt to assess, by inspection and handling of the wool in the broker's store, the fibre diameter, fibre length, soundness of staple, yield of clean fibre and other characteristics. There is a tendency today, however, for subjective judgement of wool to be supplemented by objective testing. Hand-drawn samples have been used to some extent in the past for testing, but such samples are not as truly representative of the wool in a bale as samples taken by coring. Both a motor-driven rotating metal tube and a stationary tube fitted with a razor-sharp tip, which is manually pushed into the bale, have been used for core-sampling in U.S.A. In Australia, the method of sharpening the tip has been improved and the design of the tube changed to allow the wool sample to be pushed up the tube through a slot into a plastic bag attached to the handle. This is convenient for sampling greasy wool, and is particularly valuable for sampling scoured and carbonized wools for moisture content since the wool is not exposed to the atmosphere before testing. Samples taken from greasy wool by coring are suitable for estimation of clean fibre yield and mean fibre diameter but not fibre length. Thus improved methods of coring are likely to assist in simplifying specification of the physical characteristics of individual lots of wool.

10. When trading in scoured and carbonized wool or wool tops, or when processing these products, it is often desirable to obtain an approximate moisture content. The C.S.I.R.O. Direct Reading Regain Tester has recently been developed for this purpose. A sample of wool taken either by hand or by pressure coring is placed on the pan of a specially designed balance. The position of a counterpoise weight is adjusted to bring the pointer to zero. The wool sample is then dried in a special forced hot air drying unit for several minutes and returned to the balance pan when the pointer immediately shows the moisture regain. Measurement of regain in a ½ lb sample of wool takes about 5 minutes and is accurate to ± ½%.

PREPARATION OF WOOL FOR TEXTILE PROCESSING

11. Branding fluids applied to the fleece of the sheep have long been used for identification purposes. In the past many of these, which have resisted weathering well and have remained conspicuous throughout the year between successive shearings, have been very difficult or impossible to remove from the wool in scouring. Branded portions of the fleece required special treatment to remove the brand and the value of this wool was correspondingly lowered. In addition, small traces of brand, which escaped detection, would appear in the final fabric and required special solvent treatment for their removal. Some years ago, a scourable branding fluid was developed by C.S.I.R.O. and made available in various colours. This remains on the fleece during 12 months' exposure but is readily removed from the wool during scouring and subsequent processing without special treatment. This new scourable branding fluid is estimated to be used now on about 90% of Australian sheep.

12. Of the 150 million sheep in Australia, about 30 million are slaughtered annually and most of the skins from these animals are fellmongered for the recovery of wool and pelt. Research has been

carried out in the Wool Research Laboratories on the sweating or bacterial process of loosening the wool and also on the depilatory process. The most notable improvements however, have been made in recovery of the wool from skin trimmings, from wrinkly and insect-damaged skins where recovery of the pelt is not warranted, and from short woolled skins which would be difficult to fellmonger by conventional methods. Instead of allowing this material to rot on the fellmongery floor, as formerly, it is now recommended that the skin pieces be shrunk by heating them in water at 70°C and then digested by bacteria while suspended in water at 40°C and vigorously aerated. The wool obtained is of very good colour and the process is complete in 2 to 3 days. A machine for pulling the wool from shrunken skin pieces was developed in New Zealand while testing the forerunner of the skin-digestion method outlined above. This machine is used at all New Zealand freezing works and is increasing in popularity in Australian freezing works.

13. As an alternative to fellmongering, sheepskins may be tanned with the wool on and used to cover floors, furniture, or in car upholstery. Another application, now growing rapidly in popularity, is their use by hospitals to prevent bedsores, and to provide comfort for elderly and chronic patients. Merino and crossbred skins of 60's to 64's wool quality are used for this purpose after shearing to give wool 1 inch long. The skins are chrome tanned to enable them to resist high-temperature laundering and sterilization. Washing is carried out using a neutral detergent formulation developed by C.S.I.R.O.

14. Burr and other vegetable matter is a serious contaminant of much of the Australian clip; because of its nutritional importance to the sheep the incidence of burr is not likely to decrease. Removal of vegetable matter from the wool by carbonizing is thus an important operation in the preparation of a significant amount of Australian wool for textile processing. Carbonizing consists in impregnating the wool, after scouring, with dilute sulphuric acid, evaporating away the water to concentrate the acid, baking the acid fleece to char the burr, crushing the burr by passing the wool between rollers, eliminating the charred material by shaking on a sieve, then neutralizing and washing the carbonized wool. Acid damage in this process may cause wool losses up to 10% by weight. Tendering of the wool is reflected in a high rate of yarn breakage during spinning and weaving. It has been shown that such damage is largely averted by making small additions of certain non-ionic detergents to the acid used to impregnate the burry wool. Most Australian carbonizers are following this procedure.

15. During conventional scouring of greasy wool with hot soap and soda solutions to remove wax, suint and dirt, some felting occurs which can lead to excessive fibre breakage during subsequent carding and combing. On the worsted system much of the broken fibre appears as noil in the combing operation and the ratio of top to noil, or the tear, as it is called, may be low on this account. In an alternative method developed in the Wool Research Laboratories and known as solvent degreasing, the greasy wool is fed on perforated drums and subjected to jets of dry cleaner's petroleum solvent which dissolves the grease without appreciably disturbing the wool staples. The extracted wool passes between rollers to squeeze out excess solvent and is then subjected to jets of water on other perforated drums to remove the suint and displace solvent. The wool is squeezed again between rollers and dried. Almost all the wool wax is recovered by distill-

ing off the solvent. Very little tangling occurs during solvent degreasing and higher tears are obtained from wool processed in this way when compared with wool scoured by the soap-soda process. The process is in commercial use by one of Australia's leading top-makers. A solvent degreasing pilot plant at the Geelong Division is used to prepare samples of wool for textile processing trials at woollen and worsted mills.

TEXTILE PROCESSES

16. The conventional worsted card which converts scoured wool into a carded web causes considerable fibre loss and breakage. To overcome this, a new machine is in process of development called a sliver converter. This converts the fibres into a continuous sliver at much higher production rate and with less fibre loss than the usual carding machine. It requires much less floor space than the card and production costs should be significantly lower on the new machine. The carding process itself is also under investigation. Increase in yield of top has been shown to follow the addition of certain lubricants to wool before worsted carding. No elaborate system of applying the oil is needed but an optimum viscosity in the oil has been demonstrated of about 20 centipoise.

17. A device known as the C.S.I.R.O. Comb Control Unit has been developed to provide accurate automatic control of production on the Noble comb; the device eliminates large fluctuations in production which result from manual control. The unit is being manufactured in Australia. Over 100 units have been installed in Australian mills and a number are in use in the United Kingdom and New Zealand.

18. Mixture shades such as light greys and fawns are often produced in wool yarn by the melange printing process. In this process, wool top is fed between rollers, one of which prints bars of colour across certain portions of the wool. A uniform mixture effect is then obtained by blending and gilling the printed wool. A previous disadvantage of this process was the long steaming times - often an hour or more - required to fix the dye after printing. Improvements have been made in the composition of the dye-paste applied in this process to enable the period of steaming to be greatly shortened.

FINISHING PROCESSES

19. Although the felting of wool is essential in the production of certain types of cloth which are milled for special effects after weaving, and also in producing wool felts such as floor coverings, and in certain types of fabric, for example in knitted goods, felting is usually undesirable once the products have passed into the hands of the consumer. Several methods are now available for conferring shrinkage resistance on wool goods and each has its own particular merits for particular circumstances. In a new method recently developed in Australia, the goods are treated with a solution of potassium permanganate in saturated salt solution, the coloured manganese dioxide deposited in the wool being subsequently discharged with bisulphite solution. The method does not affect the handle of the wool and it reduces pilling in knitted goods. It has been applied successfully to knitted goods, to wool blankets, to woven goods in the first stage of process (see paragraph 22), and to wool tops.

20. Dyestuffs dissolved in formic acid can be applied to wool in the cold. The wool is immersed in the formic acid solution, squeezed

for example by passing it between rollers, and after a minute or so washed in water. The individual fibres are greatly swollen during contact with the acid (this allows the dye molecules to enter), but they contract again on immersion in water. Although the process is already in commercial use for printing limited areas on wool goods where the quantity of formic acid absorbed is so small as to render its recovery unimportant, its application to the continuous dyeing of wool tops requires further investigation on a pilot-plant scale. Such investigations are in progress at the present time. The method under trial includes a formic acid distillation recovery stage.

21. Mothproofing of wool goods by impregnation with a small concentration of dieldrin, applied as an emulsion usually in one of the final stages of wet processing, has been widely adopted in this country and overseas, especially in U.S.A. Many firms in Australia are licensed to use the process under a registered name.

22. A minimum iron process, involving application of the permanganate-brine shrink-proofing treatment already described and followed by impregnation with sodium sulphite and steaming on a roller to confer a flat-setting treatment, has been developed. The process is being used on fabric for girls' uniforms and boys school trousers and also on shirting and blouse material.

23. Perhaps the best known of the C.S.I.R.O. processes to emerge from the Wool Research Laboratories is the process for inserting permanent creases in men's slacks and ladies' skirts. The method requires spraying the area of wool garment which is to be creased with sufficient of a dilute solution of ammonium thiogly-collate to give an uptake of 40% by weight. Steam and pressure are then applied on conventional equipment to complete the reaction and set the crease. The method is being widely used in Australia, U.S.A., Japan and New Zealand and to a lesser extent in Europe.

OPTIMAL USE OF WOOL GOODS

24. There is a danger that wool goods will be discarded in favour of those made from other textile fibres if their performance during use by the consumer is below the optimal, or if factual knowledge about wool is not determined reliably and publicized in the appropriate quarters. Such a situation existed in a large Melbourne hospital laundry a few years ago where the only information then available suggested that fluff from wool blankets transmitted infection in hospitals and also that wool blankets could not be repeatedly laundered and sterilized. Collection of floating fibres and bacteria in the wards of several hospitals in Melbourne, however, showed that these two constituents of the atmosphere moved independently of one another and therefore that wool fibres could not possibly be the vehicle for air-borne bacteria. Further it was shown that, provided wool blankets are first shrink-proofed, they can be boiled repeatedly to cleanse and sterilize them in a specially compounded neutral detergent mixture which removes dirt and prevents discolouration. Cleaning during boiling in fact proceeds more rapidly with wool than with cotton goods and the laundry cycle is therefore somewhat shorter. Over 300 boilings have been applied to the blankets without rendering them unserviceable.

25. Other outstanding advantages of wool are its low flammability and its heat insulating properties and general comfort when used in blan-

kets and in clothing. Research is in hand to provide reliable data on these effects. On the other hand, the yellowing of wool on exposure to sunlight is a serious disadvantage in white wool goods or in goods dyed to light pastel shades and research is in progress to elucidate this phenomenon and if possible to evolve a treatment for its prevention.

TEXTILE TESTING

26. Reference has already been made to the coring method of sampling bales of wool and to the rapid moisture regain tester. Testing methods are also being developed for application at various other stages of the industry. One of these is designed to assist the multiple tailoring industry. At present fabrics vary widely in the extent to which they relax when dampened during making up and in the extent to which their dimensions change with variation in the relative humidity of the atmosphere. New information on relaxation shrinkage and other dimensional changes in fabrics is making possible: improvement in the methods of measurement used, better dimensional stability after cloth finishing operations and more accurate control of dimensions and cockling in garment manufacture. It therefore allows the behaviour of a given fabric during making up to be predicted and an allowance to be made, if desired, for its particular shrinkage propensities.

27. Another instrument has been designed for testing felting shrinkage of wool fabrics which are likely to be laundered under severe industrial conditions. It is called the Impeller Felting Shrinkage Tester. Four tests can be run simultaneously in this apparatus and the results on samples of blanket have been shown to be directly comparable with the shrinkage results obtained on whole blankets in a large-scale hospital laundry.

CONCLUSION

28. Countries where the wool textile industry is not already well established are in a good position to adopt recently developed wool textile processes and apply scientific methods. The problem of disposing of expensive capital equipment in order to install new equipment does not arise. Moreover the personnel employed in mills would not be wedded to traditional methods and should readily accept new ideas.

BIBLIOGRAPHY

29. For general background information reference should be made to the following: Wool Research Laboratories of C.S.I.R.O. - a semi-illustrated account of the research in the laboratories up to the end of 1959, and C.S.I.R.O. Wool Research Laboratories Annual Report 1960-61; both these publications are avaliable on request to: The Chief, Division of Protein Chemistry, C.S.I.R.O. Wool Research Laboratories, 343 Royal Parade, Parkville, N.2, Victoria, Australia.

30. For detailed information reference should be made to the scientific papers listed in the C.S.I.R.O. Annual Report over the years 1950-1960 and in the Wool Research Laboratories Annual Report mentioned above. A complete list of these papers can be obtained by writing to any of the three Divisions located in Melbourne, Sydney and Geelong, and reprints of some of the papers are still available on request

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ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.6.1

Australia

METHODS OF INCREASING THE USEFULNESS OF NATURAL WOOL

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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METHODS OF INCREASING THE USEFULNESS OF NATURAL WOOL

F.G. Lennox

Research conducted since 1949 in the Australian Wool Research Laboratories, Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) to improve the utilization of wool is covered in this paper. Investigations on th structure and physical and chemical properties of wool are only briefly described. More detail is given of research to improve its handling, processing and utilization.

Improvements in the baling of wool to avoid jute contamination and increase the density of packing are described, and also the sampling of baled wool by coring for estimation of yield of greasy wool or the moisture regain of scoured and carbonized wools. Reference is made to the development of a scourable branding fluid for sheep, to improvements in fellmongering for recovery of wool from sheepskins, and to the use of tanned sheepskins for the prevention of bedsores in hospital patients. Prevention of damage to wool during carbonizing by the addition of certain detergents to the sulphuric acid used to impregnate the burry wool has been demonstrated, and a method based on the use of a petroleum fraction has been evolved for cleaning greasy wool with less risk of tangling the fibres and subsequent fibre breakage than when soap-soda scouring is used.

Among improvements described for use in textile processing are the sliver-converter as an alternative to the worsted card, a comb control unit for improving the quality of top obtained from the Noble Comb, better dye-pastes for application in melange printing, and a variety of finishing processes. Among the finishing processes are a new method for imparting shrinkage-resistance, a method of applying dyestuffs in cold formic acid solution, the use of dieldrin for conferring moth resistance, an easy-care process for wool fabrics and a process for durably creasing slacks and skirts. In research to achieve optimal utilization of wool goods a method has been evolved for laundering and sterilizing shrink-resist wool blankets without deterioration, and new testing methods to assess relaxation shrinkage and felting shrinkage have been developed.

Some of the improvements described could more easily be adopted in countries where the wool textile industry is now being built up rather than in those countries where it is already well established.

The improvements introduced in the wool industry over a relatively short period of time show what can be accomplished by the application of modern science and technology to a traditional industry dating back many hundreds of years.

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Agenda Item: D.5.4

Australia

TANNIN-FORMALDEHYDE ADHESIVES

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TANNIN-FORMALDEHYDE ADHESIVES

by

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INTRODUCTION

1. Phenolic groups occur in tannins, many of which may be reacted with formaldehyde to form resins. Some of these have potential use in the manufacture of highly reactive waterproof adhesives. In Australia, commercial tannins offer a substantial cost advantage over phenol, which is the most important raw material for waterproof plywood adhesives.

2. Some time ago the Chemical Research Laboratories examined tannins as a possible base for adhesives,[2,3] while more recently the Division of Forest Products has investigated the properties of a number of tannins as a base for waterproof adhesives. This report outlines some aspects of the investigations carried out at the Division of Forest Products.

THE TANNIN-FORMALDEHYDE REACTION

3. Mangrove (Rhizophora and Bruguiera spp.), wattle (Acacia mollissima) and radiata (Pinus radiata) bark extracts react readily with formaldehyde to form resins. Under appropriate conditions the reaction takes place comparatively rapidly at ambient temperatures, but in gluing best results have been obtained at elevated temperatures.

4. These tannins differ in rate of reaction with formaldehyde, as is shown by time taken for tannin solutions to form a gel under uniform conditions. At 60°C and at an arbitrary pH 6.0 the gelation times for radiata, mangrove, and wattle tannin were found to be 2.6, 12.5 and 55.7 minutes respectively.

5. The rate at which these tannins react with formaldehyde varies with pH, and is accelerated by certain soluble salts.[4] In the case of wattle tannin, when the gelation time is plotted against pH over a range of about 1.5 - 7.0, a maximum (region of lowest reactivity) is found at pH 3.0 - 3.5. Also the gelation time is reduced (reactivity increased) by a number of soluble salts, some of the most effective being salts of zinc, copper, chromium and aluminium. In these investigations the effects of the various salts

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[2] L.K. Dalton, Tannin-formaldehyde resins as adhesives for wood, Aust. J. Appl. Sci. 1, 54 (1950).
[3] L.K. Dalton, Resins from sulphited tannins as adhesives for wood, Aust. J. Appl. Sci. 4, 136 (1953).
[4] Plomley, K.F., The effect of soluble salts on the gelation of tannin-formaldehyde, Aust. J. Appli. Sci. 10, 494-497 (1959).

were compared at a concentration of 10 per cent of the dry wattle tannin. Later work has shown that less than 2 per cent of the more effective salts can produce a substantial acceleration of gelation.

TANNIN-FORMALDEHYDE ADHESIVES FOR PLYWOOD MANUFACTURE

Adhesive Properties of Different Tannins

6. Early studies on mangrove tannin[5] showed that by using simple formulation it was possible to prepare adhesives which in shear strength tests complied with the waterproof requirements of the Australian Standard for synthetic resin adhesives for plywood. Values for wood failure, however, were uniformly low and could not be regarded as satisfactory. It was found that waterproof adhesives giving high values for shear strength and wood failure and able to withstand immersion in boiling water for 72 hours, could be prepared by adding a small proportion of a suitably formulated phenolic resin.

7. Two other commercial tannin extracts, viz. wattle and wandoo (Eucalyptus wandoo and E. accedens) were also examined. Table 1 shows the differences in adhesive properties between the three extracts and also the effect on the quality of the bond with klinki pine (Araucaria klinkii) of adding varying amounts of fortifying resin.

Table 1

EFFECT OF ADDING FORTIFYING RESIN[a] ON BONDS OF KLINKI PINE USING TANNIN-BASED ADHESIVES

Amount of fortifying resin (%) (dry solids basis)	Mangrove		Wattle		Wandoo	
	Tested dry	Tested wet after 6-hr boil	Tested dry	Tested wet after 72-hr boil	Tested dry	Tested wet after 72-hr boil
0	309[b]- 11[c]	120[b]- 0[c]	290- 47	236-100	165- 5	0- 0
10	278 - 24	200 - 35	390- 97	290-100	301-52	150-21
20	314 - 50	203 - 56	481-100	296-100	369-96	248-83
30	340 -100	305 -100	423-100	300-100	382-82	266-93

[a] Phenol formaldehyde resin used with mangrove tannin; with the other two species a resorcinol phenol formaldehyde was used.

[b] Glue shear strength (lb/sq in) - Tested according to Aust. Stand. Spec. No. K.88, 1952, (min mean failing load = 200 lb).

[c] Wood failure (%).

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[5] Plomley, K.F., Gottstein, J.W., and Hillis, W.E., Tannin-formaldehyde adhesives, C.S.I.R.O. For. Prod. Newsl. 234, 6-8 (1957).

Effect of Alkali on Adhesive Properties.

8. When developing a formulation for a mangrove tannin adhesive, it was observed that addition of highly alkaline commercial phenolic resins to the tannin solution produced a mix of unsatisfactory physical characteristics. This was due partly to precipitation of the commercial phenolic resin at the lower pH and partly to the effect of the alkali on the tannin.

9. Wattle and radiata tannins do not show such marked changes on the addition of alkali as does mangrove tannin. However, recent investigations have demonstrated that the use of alkaline glue mixes or of alkaline tannin extracts may result in an inferior bond. Under alkaline conditions the reactivity of the tannin is high and the solubility of paraformaldehyde (the form in which formaldehyde is generally added to the adhesive) is increased, leading to premature reaction of the materials. It was also found that exposure of the tannin to moderately high pH for 72 hours resulted in a reduction in the bond quality observed after immersion in boiling water for 6 hours.

Bond Strength of Wattle Tannin Adhesives with Different Veneers.

10. Comparatively simple tannin-formaldehyde mixes are effective for bonding plywood. A typical formulation consists essentially of a concentrated solution of the tannin in water adjusted to a suitable pH, with paraformaldehyde as the cross-linking agent, and with or without a small amount of fortifying resin. Wood filler is also added to minimize loss of adhesive through penetration and to provide gap-filling properties.

11. The bond strength of wattle tannin formulations with different commercial veneers has been investigated. Some typical results are given in Table 2 showing that wattle tannin without fortifying resin can produce a satisfactory bond with some species of veneers, but with others a small addition of a fortifying resin is necessary. Because of the variation in surface uniformity and absorptivity of veneers, and the brittle nature of the tannin-formaldehyde resin, the addition of wood flour is necessary with all mixes. The addition of fortifying resin is probably desirable with most species in order to make certain of consistently satisfactory bond quality, although unfortified wattle tannin may be generally suitable for producing a low-cost bond with high, but not necessarily maximum strength.

12. A number of trials of wattle tannin adhesives have been made under factory conditions. The results obtained with rotary peeled veneers have confirmed laboratory experience, which indicates that tannin-formaldehyde is suitable for bonding a number of commercial veneers. So far no failures have been experienced, although, because of dark colour and a tendency to penetrate, tannin adhesives are not at present recommended for bonding thin decorative face veneers.

TANNIN-FORMALDEHYDE ADHESIVES FOR BONDING PARTICLE BOARD.

13. Although investigations have been largely concentrated on the development of adhesives for plywood, some exploratory tests have been carried out with wattle tannin as a binding agent for wood particle board. These indicate that a satisfactory board can be prepared from Pinus radiata chips and unfortified wattle tannin

Table 2

BOND STRENGTH OF WATTLE TANNIN ADHESIVE FORMULATIONS WITH DIFFERENT VENEER SPECIES

Veneer Species	Concentration of Fortifying Resin (%)					
	0		10		20	
	Tested dry	Tested wet after 72-hr boil	Tested dry	Tested wet after 72-hr boil	Tested dry	Tested wet after 72-hr boil
Hoop pine[a]	388[f]-93[g]	250-92	370- 97	305- 86	362- 92	290-90
Borneo cedar[b]	293 -88	233-87	321-100	302-100	309- 92	307-94
Ramin[c]	314 -62	259-73	356- 63	274- 64	373-100	238-65
Coachwood[d]	347 -43	300-80	428- 87	262- 95	420- 89	340-98
Mountain ash[e]	330 -91	248-99	324- 71	241- 98	344- 93	250-98

[a] *Araucaria cunninghamii*; [b] *Shorea* sp.; [c] *Gonystylus* sp.;

[d] *Ceratopelum apetalum*; [e] *Eucalyptus regnans*;

[f] Shear strength (lb/sq in); [g] Wood failure (%).

adhesive. In this application, however, the colour of the adhesive may limit its usefulness unless the surface of the board is to be veneered or otherwise covered. In addition, deficiency in tackiness can have an undesirable effect in board forming.

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TANNIN-FORMALDEHYDE ADHESIVES

by

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Mangrove, wattle and Pinus radiata bark extracts react readily with formaldehyde to form resins. The reaction rate varies with species and type of extract and is influenced by pH and the presence of certain soluble salts in small amounts.

Using simple formulations, it is possible to prepare waterproof adhesives which will withstand immersion in boiling water for 72 hours. The adhesive properties of three commercial tannin extracts studied differ considerably. Bond quality can be improved by adding a small amount of suitably formulated phenolic resin to the adhesive mix. The use of alkaline adhesive mixes or tannin extracts may result in decreased bond quality.

Tannin adhesive formulations which produce a satisfactory waterproof bond with commercial veneers have been developed. Trials under factory conditions have been made with wattle tannin adhesives. The trials have confirmed laboratory experience with rotary peeled veneers, but, because of dark colour and a tendency to penetrate, the adhesives are not at present recommended for bonding thin decorative face veneers.

Exploratory tests indicate that wattle tannin-formaldehyde is suitable for bonding Pinus radiata chip board. However, in this application the colour of the adhesive may limit its usefulness. In addition, deficiency in tackiness can have an undesirable effect in board forming.

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PRESSURE HYDROMETALLURGY APPLIED TO LOW-GRADE ORES

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PRESSURE HYDROMETALLURGY APPLIED TO LOW-GRADE ORES

T.R. Scott[1]

INTRODUCTION

1. There is no need for pressure hydrometallurgy to be confined to highly industrialized areas. Today pure alumina is being made from bauxite in the West Indies, South America and West Africa by one of the oldest and best-known processes of pressure hydrometallurgy, viz. the Bayer process using caustic soda at temperatures of 150 and 160°C. Likewise, pressure digestion of complex lead, zinc and copper ores is being initiated in the Philippines, using ammoniacal solutions, while a complex operation using sulphuric acid under pressure for the recovery of nickel has been set up in Cuba. This paper will describe briefly the scope and advantages of pressure hydrometallurgy and will illustrate by a few examples the possibilities of treating low-grade ores.

ADVANTAGES AND SCOPE

2. The major advantages of pressure hydrometallurgy are that reactions are faster and the products of reaction are often different, in comparison with operations at ordinary temperatures. It is not proposed to give an extensive bibliography since two excellent reviews have appeared in the past ten years[2,3] and further up-to-date references will appear in the A.I.M.E. Symposium on "Unit Processes in Hydrometallurgy" to be held in Dallas, Texas, U.S.A., in February 1963.

3. The scope of pressure hydrometallurgy is limited only by expense. There are many operations (e.g. cyanidation of gold ores) which are sufficiently effective at ordinary temperatures and which would not require or warrant the use of pressure techniques. Moreover, corrosion problems, especially in acid environments, are more serious at high temperatures and pressures, so that materials of construction are liable to be relatively costly in certain circumstances.[4] Nevertheless, as the following examples will show, there are many instances where great benefit can accrue from the application of high pressures and temperatures in the treatment of low-grade ores. Cost of special equipment is more than compensated by the speed of reaction and the consequent high throughput which can be realized.

EXAMPLES OF PROCESSES

4. The alkaline process used by Sherritt Gordon Mines Ltd. at Fort Saskatchewan, Alberta, Canada, is an outstanding example of a procedure which can be applied to a variety of sulphide ores, irrespective of grade in many instances. It is also of interest in that ammonia under pressures of 100-110 p.s.i. is used to form the soluble amines of nickel, cobalt and copper, although temperatures are only in the region of 80-90°C. By comparison, at a later stage in the process nickel is precipitated as metal using hydrogen at 500 p.s.i. and at temperatures up to 200°C. A distinction can thus be drawn between pressure due to added gases and steam pressure due to operation in aqueous solutions at temperatures above 100°C.

5. The mineral pyrite (FeS_2) is only attacked very slowly by dilute acid at room temperatures, yet at 180°C in the presence of air or oxygen it is rapidly oxidised to form ferric sulphate, which in turn is simultaneously hydrolysed to form ferric oxide and sulphuric acid.[5] Hence pyrite in low-grade ores can be used as a cheap source of sulphuric acid which can be used simultaneously to dissolve small amounts of uranium,[6] copper, nickel etc., which may be present in the ore. This type of process is particularly suitable where sulphuric acid itself is expensive, where the gangue minerals in the ore are relatively unreactive, and where the valuable minerals in the ore are difficult to recover by physical methods of ore-dressing. The principle can naturally be extended to low-grade mixtures of many other sulphide minerals which are not responsive to the more conventional methods of concentration.

6. When sulphuric acid is relatively cheap it can be used partly expendably for the treatment of low-grade ores, such as the nickeliferous laterite occurring in large deposits in Cuba. Here the Freeport Nickel process[7] was used to treat economically an ore containing only 1.35% Ni and 0.13% Co. The material also contained large amounts of iron and aluminium which were readily soluble at ordinary temperatures in dilute acids, but by operating at 230°C and at pressures up to 500 p.s.i., remarkably selective leaching of nickel and cobalt was achieved in short treatment series. This example serves to demonstrate that advantage can be taken of the large changes in solubility of some metallic sulphates at elevated temperatures.

7. In contrast to the above example some ores become more reactive at high temperatures. This applies to a variety of aluminous ores, such as bauxite, calcined clays etc., and has been used both in the Bayer process (using caustic soda) and in a new acid process.[8] With sulphuric acid as the solvent high recoveries of alumina can be obtained at temperatures around 180°C in only 30 minutes and, by using a suitable 2-stage digestion process, iron contamination of the aluminium sulphate solutions can be reduced to a sufficiently low level for subsequent processing. The major advantage of this acid process is that it can be applied to low-grade bauxites which contain too much silica for economic treatment by the conventional Bayer process.

8. The effect of temperature on the stability of solutions can also be put to good use. With ferric and aluminium sulphates solutions which are quite stable at ordinary temperatures hydrolyse readily above 100°C and thus enable separations or recoveries to be made. In the case of aluminium a pure basic aluminium sulphate can be recovered in 60% yield by heating the appropriately treated solution[9] for only 10 minutes at 220°C. If residual iron is present in the ferrous state, advantage can be taken of the fact that this salt does not hydrolyse under the operating conditions and a pure aluminium compound can thus be recovered.

CONCLUSIONS

9. Even with the few examples given, it is clear that pressure hydrometallurgy as a technique opens up new fields of chemistry, particularly as regards the treatment of otherwise refractory material and the opportunities for making useful separations not feasible at lower temperatures. In the writer's experience it has also been found that the reaction mixtures produced at high temperatures tend in many instances to filter or settle better than their counterparts at lower temperatures. In addition, the speed and very often the selectivity of reactions favour the use of pressure hydrometallurgy in many fields where low-grade ores are difficult to treat; despite the need for closer control and more elaborate equipment. In view of the successful commercial operation of several of the examples cited, it is evident that the cost of working at high temperatures and pressures is no barrier to the development of useful processes.

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[1] Division of Mineral Chemistry, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia.

[2] Gray, P.M.J., Pressure hydrometallurgy, Rev. Pure and Appl. Chem. 5 (No.3), 194-216 (1955).

[3] Forward, F.A., and Halpern, J., Hydrometallurgical processes at high pressures. Trans. Inst. Min. & Metall., 66 (Pt.5), 191-218 (1957).

[4] Simons, C.J., Novel designs tame tough corrosives, Chem.Eng., 66, 130-134 (1959).

[5] Warren, I.H., The generation of sulphuric acid from pyrite by pressure leaching, Aust. J. Appl. Sci., 7, 346-358 (1956).

[6] Gray, P.M.J., The extraction of uranium from a pyritic ore by acid pressure leaching, Trans. Inst. Min. Metall., 65, 55-64 (1955).

[7] Carlson, E.T., & Simons, C.S., Acid leaching Moa Bay's nickel, J. Metals, 12, 206-213 (1960).

[8] Scott, T.R., Alumina by acid extraction, J. Metals, 14, 121-125 (1962).

[9] Davey, P.T., and Scott, T.R., Hydrolysis of aluminium sulphate at elevated temperatures, Aust. J. [illegible], in press (1962).

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Australia

PRESSURE HYDROMETALLURGY APPLIED TO LOW-GRADE ORES

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PRESSURE HYDROMETALLURGY APPLIED TO LOW-GRADE ORES

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The majority of hydrometallurgical processes are done at atmospheric pressure and temperature, but it is desirable with some ores to use higher temperatures and pressures greater than atmospheric in order to achieve the best results.

Advantages of this specialised approach include faster reactions and products different from those obtained under ordinary conditions. It is also possible to obtain selective recovery of valuable materials or selective hydrolysis of impurities by judicious control of the operating conditions.

Examples are given to illustrate current and potential applications of pressure hydrometallurgy with special reference to low-grade ores.

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Australia

FUNDAMENTAL FACTORS INFLUENCING THE BEHAVIOUR OF PAPER PRODUCTS UNDER EXTREME CLIMATIC CONDITIONS

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FUNDAMENTAL FACTORS INFLUENCING THE BEHAVIOUR OF PAPER PRODUCTS UNDER EXTREME CLIMATIC CONDITIONS

H.G. Higgins[1] and A.J. Watson[1]

INTRODUCTION

Climate and Economic Development

1. The lack of economic development in many parts of the world is related partly to the prevailing climate, which may constitute a severe disability in respect to human health or comfort or which may restrict the practice of agriculture or forestry. Even when factors such as soil, terrain, mineral resources, access, and the social and political structure favour industrial development, it may be retarded if its circumstances are not those engendered by an equable climate. This may apply particularly to those industries processing biological material. The transitions from a traditional craft to a large-scale industry, and from batch to continuous production introduce many new problems which may be aggravated by prevailing climatic conditions.

Use of Paper in Less Developed Areas

2. Although papermaking originated in China and gradually spread to the Middle East and then to the West where it became a traditional craft, it has become a large-scale industry only in comparatively recent times. Like many other industries which involve the processing of a raw material, it has flourished mainly in temperate regions and consequently the practical problems of manufacture and use under the more extreme climatic conditions are understood in a relatively imperfect way. However, a considerable amount of information is available on the scientific level which allows us to predict with some degree of confidence the response of paper and other cellulosic products to climatic extremes. In this connection we are concerned particularly with countries experiencing a warm, moist climate, such as some of the newer nations of Africa, and with those experiencing a very hot, dry climate, such as the countries of the Middle East.

3. The use of paper for many purposes, such as printing on modern machines, requires higher specifications than was formerly the case in respect to such properties as strength and dimensional response to humidity variations, and the extreme conditions of environment would tend to accentuate any difficulties which might arise in the

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TABLE 1

CLASSIFICATION OF PAPER PROPERTIES:

Structural Mechanical	Optical	Electrical Chemical

FACTORS INFLUENCING PAPER PROPERTIES:

Environment	Fibre Properties	Formation (homogeneity)
Relative humidity	Dimensions	Wet Pressing
Temperature	Flexibility	Drying Tensions
Inter-Fibre Bonding	Crystallinity	Chemical Treatment
Hydrogen bonds	Swelling propensity	Calendering
Additives	D.P. of carbohydrates	Coating
Fillers, Sizes, Dyes.	Lignin content	
	Hemicellulose content	
	type	

FACTORS INFLUENCING FIBRE PROPERTIES:

Biological Origin	Pulping Methods	Drying and Re-wetting
Species, Age, Locality.	Bleaching	Beating

process of manufacture or subsequent treatment. Thus the extension of industry, literacy, hygiene, technology and science to the less developed countries will tend to give rise to new problems in the paper industry, and at such times and places as could make their solution difficult unless a clear understanding be gained from the outset of the factors influencing paper behaviour. At relatively low levels of industrialization it is not to be expected that facilities for controlling temperature and humidity will be readily available in paper mills, printing works etc..

Factors Influencing Paper Properties

4. The main groups of paper properties, the factors influencing them and the way in which fibre properties may have been determined by the beginning of the actual papermaking stage, are indicated in Table 1. The paper properties are determined in a complex way by the various factors indicated, but we shall be concerned here only with the effects of environment and in particular of relative humidity and temperature.

EFFECTS OF HUMIDITY

Mechanical Properties

5. The way in which strength properties vary with moisture content (and hence with relative humidity) is quite well known and has recently been summarized by Brecht[2]. Those properties depending

[2] Brecht, W., The effect of structure on the major properties of paper behaviour with fluids. In "Formation and Structure of Paper" (Proc. Oxf. Symp. 1961) Brit. Pap. Board Makers Assoc. Lond.

mainly on inter-fibre bonding, such as breaking load and bursting strength, pass through a maximum in the vicinity of 5 per cent. moisture content, whereas other properties, such as tearing strength, breaking strain and folding endurance, may have a maximum value at considerably higher moisture contents. The response of the various mechanical properties to relative humidity changes may vary with the composition of the pulp, its processing, and the pulping method; the chemical composition will influence the equilibrium moisture content attained. The general effect of increasing moisture content on the stress-strain curve of paper[3] is to decrease the stress at a given extension.

6. The response of paper to changes in moisture content depends to some extent on the nature of the fibrous elements in the sheet, so that factors such as fibre length and cross-sectional dimensions may have a significant effect. The development of mechanical properties on drying depends on the composition and processing of the pulp. Thus the tension which develops in paper made from unbeaten pulp increases sharply when the moisture content falls below about 30%, but, after air-drying, the maximum tension attained in this case will not surpass that in a paper made from very highly beaten material dried only to a moisture content of about 50%.[4]

Dimensional Stability

7. Dimensional stability is a factor of paramount importance in many paper applications, for example multi-colour printing and punch card systems. Dimensional instability may lead to a variety of difficulties in manufacture which are usually referred to as "curl" and "cockling". These effects have been studied in considerable detail by Gallay and co-workers.[5]

8. The basic finding in respect to dimensional stability is that the expansion is proportional to the change in moisture content,[6] but that the factor of proportionality depends on various influences.[2] One of the most important of these is the degree of beating, both the amount and rate of shrinkage on drying having been found to increase with beating.[4] The type of pulp has a smaller effect than beating, but is nevertheless significant. Brecht[2] has found that the rate of expansion, on moistening, in a series of chemical and semi-chemical pulps does not vary greatly with yield in the range 25-65% R.H., but in the range 65-90% the rate was found to decrease with increasing yield, pulps with higher lignin content reacting more slowly. Groundwood has a much lower expansion for a given moisture uptake than other types of pulp, presumably owing to poorer bonding of its lignified and rigid fibres; account should also be taken of the fact that the sorption isotherm will depend on pulp composition.

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[3] Higgins, H.G., The structure and properties of paper - IX Some Critical problems. Appita, 12, 1-24 (1958).
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[5] Glynn, P., Jones, H.W.H., and Gallay, W., Drying stresses and curl in paper. Pulp and Paper Mag. Can., 62, T39-T48 (1961).
[6] Rance, H.F., Effect of water removal on sheet properties. Tappi, 37, 640-654 (1954).

9. The orientation of fibres in the sheet, or the degree of anisotropy, is also of significance for dimensional stability, the expansion being considerably less in the direction of fibre orientation. The higher expansion in the cross-direction can be related to the well-known large lateral expansion of fibres (and of wood); very small effects are observed in the longitudinal direction. Differences in fibre orientation are of great significance in the development of curl, as has been shown by experiments in which the differential between the speed of the wire, and the speed at which the fibre suspension meets the wire, is varied. The non-uniform fibre orientation through the thickness of the sheet is the basic cause of curl,[5] but by increasing the degree of anisotropy on the wire side, the non-uniformity in the vertical direction is increased. Curl may also occur when changes in atmospheric humidity take place on only one side of the paper.

10. The significance, in the present context, of these and many other similar observations, is that the difficulties encountered under temperate conditions are apt to be magnified under extreme climatic conditions if the prevailing range of humidity is greater than that normally experienced, if the magnitude of the effect under the prevailing conditions (either at high or very low humidity) is greater than it is under more normal conditions, or if the product has been manufactured elsewhere and is subjected to the extremes of humidity and temperature without a proper period of conditioning.

Biological Effects

11. Biological attack occurs principally under conditions of combined high temperature and humidity, such as occur in many tropical countries. Fungal activity may lead to discolouration and staining, and in more extreme cases to weakening of the paper. These effects may be enhanced by the presence of organic materials such as starch or casein in coated paper. Consideration can be given to the use of fungicides to reduce attack, but great care needs to be taken to avoid the use of highly toxic materials, such as phenyl mercuric acetate, for purposes where the product may come into contact with food or in other situations where the toxicity may not be realized by inexperienced people.

EFFECTS OF TEMPERATURE

Chemical Changes

12. Serious chemical changes, such as oxidation, take place very slowly in cellulosic materials at terrestrial temperatures, even at the extremes likely to be encountered in tropical arid zones. However, these changes may be accelerated by the presence of non-cellulosic polysaccharides, moisture etc. The combined effects of temperature and humidity, for example in sponsoring drying of the material, may be quite serious, leading to embrittlement and loss of strength. Degradation is likely to be accelerated by ultra-violet or visible light which may, in the presence of oxygen, give rise to functional groups which will cause discolouration.

Fibre Type

13. These changes will depend on the nature of the fibre to a

large extent. Cotton by virtue of its purity and relatively high crystallinity, is not affected by processes of degradation to the same extent as many wood pulps in which hemicellulose and small amounts of lignin may still be present, and in which the proportion of the amorphous material is greater, thus providing higher accessibility for chemical attack.

Pulping and Bleaching

14. The amount of lignin and hemicellulose remaining in the fibre depends on the method of pulping and its severity in any particular case. In order to provide maximum stability to chemical degradation under extreme temperatures, efficient washing out of the pulping liquor should be effected, as the retention of cooking and bleaching chemicals will tend to sponsor oxidation, perhaps over a long period. It might be expected that the high-yield pulps would have a lower resistance to ageing than the more highly purified pulps. Sulphate pulps are reputed to have better ageing resistance, both in respect to strength and colour, than sulphite pulps[7]. Groundwood often exhibits relatively poor ageing resistance, and where newsprint is required for archives, this may be a serious disadvantage, unless special editions are printed for this purpose on paper of higher quality.

RESTRICTIONS ON USE UNDER EXTREME CONDITIONS

Packaging and Wrapping Materials

15. In extremely wet climates, or under conditions where condensation is likely, many conventional packing and wrapping papers may be rather unsuitable for use unless special precautions are taken to provide them with adequate wet strength. Another factor to be considered is the moisture vapour permeability of the wrapping papers, which may have to be lower under extremes of humidity than that normally considered adequate for temperate climates. These difficulties can usually be overcome by careful attention to the most suitable grades of product for use in the particular situation, but they do impose restrictions on the indiscriminate use of packaging and wrapping materials on the basis of their market availability.

Printing and Writing Papers

16. As mentioned above, precautions against changes in dimensions consequent upon humidity fluctuations are essential for printing operations, and unless high specifications are adhered to considerable difficulties are likely to be encountered in regions with extreme climates. Coated papers may provide greater stability and adequate printing and writing surfaces, but the advantages of specific coatings must be weighed against the enhanced risk of biological attack when the humidity is high.

Photographic Papers

17. The coatings used for photographic papers provide excellent nutriment for micro-organisms under conditions of high humidity,

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[7] Giertz, H.W., A comparison between sulphate and sulphite pulp. Svensk Papperstidn. 56, 893-899 (1953).

and precautions are usually taken to ensure that such papers are stored in the presence of a desiccant. Another geographical hazard, not strictly climatic, is the high level of radioactivity in various parts of the world; considerable difficulties have been reported in respect to the clouding of photographic papers when the pulps have been manufactured in regions where the process waters have been contaminated by fall-out.

TREATMENTS TO EXTEND UTILIZATION

Sizing and Coating

18. Sizing can reduce dimensional changes, but with starch or gelatine sizes the biological hazard remains unless fungicides are incorporated. With rosin alum sizes, this hazard is reduced. The use of high wet strength papers represents another method of extending utilization; various synthetic resins may be used for this purpose. For coated papers which are to be used under extremely high humidity, materials other than casein, with its susceptibility to biological attack, should be considered.

Chemical Modification

19. Dimensional stabilization of paper has been attempted by cross-linking with formaldehyde and other reagents,[8] and by reducing the hydrophilic nature of the cellulose by acetylation.[9] These treatments, although expensive, may find some application to papers to be used under extreme conditions. Another approach to the rendering of paper more stable is the work now being done on grafting polymeric materials to cellulose.[10] Any reduction in the hydrophilic nature of the material should be accompanied by a corresponding improvement in dimensional stability. Plastic coated papers may also find increasing use under stringent conditions.

Choice of Raw Material

20. It is to be expected that materials of relatively high resistance to chemical degradation and relatively low response to swelling by water will find a greater use in extreme than in temperate climates. These properties will, in general, be possessed by natural fibres other than wood and by carefully purified wood pulps. However, economic factors would have to be considered before these types of material were preferred, and a compromise effected between the physical properties required.

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8 Stamm A.J., and Cohen, W.E., Swelling and dimensional control of paper. Appita, 10, 346-393 (1956).
9 Stamm, A.J., and Beasley, J.N., Dimensional stabilization of paper by acetylation. Tappi, 44, 271-275 (1961).
10 Schwab, E., Stannett, V. and Hermans, J.J., Grafting on to cellulose and cellulose fibres. Tappi, 44, 251-256 (1961).

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FUNDAMENTAL FACTORS INFLUENCING THE BEHAVIOUR OF PAPER PRODUCTS UNDER EXTREME CLIMATIC CONDITIONS

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FUNDAMENTAL FACTORS INFLUENCING THE BEHAVIOUR OF PAPER PRODUCTS UNDER EXTREME CLIMATIC CONDITIONS

H.G. Higgins and A.J. Watson

The relationship between climate and economic development is briefly outlined with particular reference to the manufacture and use of paper. The extension of industry, hygiene, technology and science to the less developed areas presents new problems in this field, the solution of which will be difficult unless the fundamental knowledge available on the factors influencing paper properties is appreciated and applied. The way in which humidity affects the mechanical properties is discussed. The practical significance of dimensional stability is emphasized in relation to the phenomena of curl and cockling in paper, with some reference to the influence of fibre orientation. Conditions under which biological degradation of paper may take place are mentioned. The effects of temperature on degradation, particularly in association with low humidity, and the way in which changes in cellulose fibres depend on the presence of non-cellulosic constituents and on methods of pulping and bleaching are considered. Attention is drawn to factors which may restrict the use, under extreme climatic conditions, of packaging and wrapping materials, printing and writing paper, and photographic paper. Such properties as wet strength, moisture vapour permeability, dimensional changes, the presence of coatings and the radioactivity of pulp are significant in particular instances. The utilization of paper in regions with extreme climates may possibly be extended by conventional sizing and coating treatments, by chemical modifications to reduce the hydrophilic nature of the fibre, including grafting of polymers to cellulose, and by the wider application of plastic-coated papers. The nature of the raw materials may also be significant in determining the suitability for use under extreme conditions.

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